

# MACHINE DESIGN

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### 3

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2. Author's last name (see Author Index for complete name). Departments in regular issues are denoted by the following code:

N/T .....	News/Trends
Scan .....	Scanning the Field for Ideas
DIA .....	Design in Action
DI .....	Design International
CD .....	Conference Digest
AD .....	Abstracts for Design

3. Date of issue, **MACHINE DESIGN Reference Issues** are denoted by the following code:

EC .....	Electric Controls (March 13)
S .....	Seals (June 19)
F&J .....	Fastening & Joining (Sept. 11)
MD .....	Mechanical Drives (Dec. 18)

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Ultrasonic Testing of High-Strength Alloys	N/T	11/13 18	(0.5)
Parts From Aluminum Powder	CD	3/6 164	(2.5)
Copper Beats Out Steel In Saturn Injector	Khol	7/10 110	(5.0)
Designing With Titanium	Scan	6/24 121	(0.8)
Hard Chromium	CD	12/11 190	(1.5)
	Hart	5/15 144	(4.0)

### 53, 54. Plastics, Rubber & Elastomer

Structural Behavior of Plastics	CD	7/10 152	(2.4)
Fortified Thermoplastics	Jones	11/13 205	(3.0)
What's Ahead for Stamped Plastics	Lavole	12/11 149	(5.0)
Mechanical Applications For Filled TFE	CD	1/9 162	(2.0)
New Developments in Contact Bearings	CD	6/24 134	(2.3)
Plastic Carb Keeps Its Cool	Scan	6/24 119	(0.7)
Mechanical Applications for Filled TFE	CD	1/9 162	(2.0)
Conductive Plastics	Litant	10/16 168	(5.0)

### 55, 56. Joining Materials, Other Nonmetals

High-Temperature Structural Adhesives	Petrie	5/15 175	(5.0)
Adhesive Bonding	Sharp	F&J 9/11 119	(9.8)
Sealants	Stein	8/6 19	85 (10.0)
Welding and Welding Alloys	Rudy	F&J 9/11 104	(6.8)
Brazing and Brazing Alloys	Pattee	F&J 9/11 111	(4.6)
Soldering and Soldering Alloys	Smith & Borcina	MD 12/18 60	(6.0)
Fluorine Doesn't Bother Glassy Carbon..	N/T	12/25 12	(0.5)

For Boeing's 747: 7-Ply Windshield 2 in. Thick

Designing With Felt

Polywater: It Freezes At -40 C., Boils At 500

N/T 4/17 14 (0.5)  
Becker 6/26 113 (13.0)

N/T 8/7 14 (0.5)

### 57. Finishes, Coatings, Lubricants

Finishes and Coatings	(Chapter)	F&J 9/11 9	(3.0)
'Umbrella' Found For Supersonic Rain.	N/T	9/18 34	(0.5)
Vinyl Dispersion Coatings	Palkie	8/7 115	(3.0)
Teflon-S: Tough Skin for Slippery Parts	N/T	2/20 40	(2.0)
Nonspray Plastic Coatings	CD	2/6 160	(2.0)
Synthetic Lubricants	Fairbanks, Knapp & Lazarus	7/10 140	(9.0)
Dry-Lubricant Films	Kirkpatrick & Young	5/15 163	(3.0)
Bonding Dry-Film Lubricants	Paulus	12/25 68	(6.0)
Accelerating Lubricants Tests	CD	10/16 188	(2.2)
Sputtering Solid Lubricants	CD	12/25 86	(1.0)

### 58. Prefabricated Forms

Fiber-Metal Matrix Composites	Weeton	2/20 141	(16.0)
The Composite Aircraft	N/T	9/4 18	(1.0)
Joining Fiber-Reinforced Composites	CD	5/1 194	(2.4)
Composite Material Beef up Chopper Blade	Scan	8/7 112	(0.5)
Joining Metal Tubing	(Article)	12/25 61	(4.0)
Jack-In-the-Box Mast Snaps Into Shape	Scan	12/11 154	(1.0)

# Manufacturing Methods and Processes

## 61-63. Metals Casting, Shaping, Forming

Hollow Castings	Webb	3/6 130	(4.0)
Designing With Titanium	CD	12/11 190	(1.5)
Plastic Moldings—or Metal Die Castings? "Machined Forgings" Produced by New Metal-Forming Process	Dreger	6/24 113	(4.0)
165-mm Projectile Cold Extruded from Steel Disc	N/T	10/30 10	(0.7)
Forged Powder Metal	N/T	9/18 18	(0.5)
Precision Controls Developed for P/M Parts	Khol	4/3 142	(5.0)
High Pressure Forming	N/T	11/13 34	(0.7)
Formability of Stainless Steels	Khol	1/9 124	(7.0)
Panel Joiner Zips Up Metal Roof Tin-Can Tight	Kopecki	2/6 149	(4.0)
What's Ahead for Stamped Plastic	Scan	5/29 110	(1.0)
	Lavoie	12/11 149	(5.0)

Smallest Laser Weld Created On Production Line	N/T	1/9 12	(0.5)
Laser Welding	Lavoie	2/20 136	(5.0)
Explosive Welding	Lavoie	7/10 125	(5.0)
Brazing Technique Solves Aluminum-Radiator Problems	N/T	2/6 12	(0.5)
Brazing and Brazing Alloys	Pattee	F&J 9/11 111	(4.6)
Soldering and Soldering Alloys	Smith &	F&J 9/11 116	(3.0)
Bonding Dry-Film Lubricants	Paulius	12/25 68	(6.0)
Adhesive Bonding	Sharpe	F&J 9/11 119	(9.8)
Fastening Plastics to Nonplastics	CD	4/17 308	(2.6)
Multidirectional Drill Motion Cuts Machining Time	Scan	5/15 151	(0.8)
Wire-Screen Grinder Machine "Anything"	N/T	11/27 12	(0.5)
Electrochemical Machining	Aaron & Wolosewicz	12/11 160	(8.0)
Flexibility Added to Electrochemical Machining	N/T	11/13 10	(0.5)

## 64-66. Metals Joining, Removal, Treating

Welding and Welding Alloys	Rudy	F&J 9/11 104	(6.8)
Joining Metal Tubing	(Article)	12/25 61	(4.0)
Trends in Fastening and Joining	Chapter	F&J 9/11 3	(1.0)
Specifying Welding Electrodes	Reid	2/6 146	(3.0)
Assembly-Line Shipyard Builds Warships Upside Down	N/T	4/3 12	(0.6)
Arc-Welded Fasteners	Singleton	F&J 9/11 41	(3.0)
Resistance-Welded Fasteners	Schafft	F&J 9/11 38	(2.8)

## 67-69. Metals Finishing, Plastics Processes

Finishes and Coatings	Chapter	F&J 9/11 9	(3.0)
Designing Plated Plastic Parts	CD	2/20 178	(3.0)
Robot Speeds Production of Blast-Coated Parts	N/T	2/23 12	(0.7)
Plastic Moldings—or Metal Die Castings? "Impossible" Parts Produced by Rotational Molding	Dreger	6/24 113	(4.0)
Automatic Assembly	N/T	10/2 49	(1.7)
Automatic Assembly	Benes	3/20 191	(14.0)
	Benes	F&J 9/11 129	(3.0)

# Design Theory and Techniques

## 71-73. Mechanics, Strength of Materials and Parts

International Mechanisms Group Established	N/T	10/30 42	(0.7)
Practical Rotor Dynamics—1: Geometric Properties of Rotors	Rasmussen	2/6 142	(4.0)
Practical Rotor Dynamics—Part 2: Load/Deflection Relationship	Rasmussen	2/20 157	(5.0)
Practical Rotor Dynamics—Part 3: Natural Frequencies & Critical Speeds	Rasmussen	3/6 158	(5.0)
Instrument Selection	Tuskin	5/29 117	(9.0)
Avoiding Vibration Damage	Tuskin	6/26 140	(4.0)
Prognosis With Plastic Models	Bannister	8/21 135	(5.0)
Missile Maker Minors In Music	N/T	4/17 10	(0.6)
Origins of Noise	Mitchell & Lynch	5/1 174	(5.0)
Fastener Evaluation	Brenner	F&J 9/11 24	(2.6)
Stress and Deflection	Krupka & Mutyla	5/29 129	(4.0)
Basic Course in Failure Analysis	Lipson	10/16 146	(5.0)
Planning for Strength	Lipson	10/30 108	(5.0)
Microperformance of Metals	Weinstein	12/11 174	(8.0)
Basic Course in Failure Analysis—Failure Modes	Lipson	11/13 222	(4.0)
Damage-Tolerant Design	Osgood	10/30 91	(5.0)
Sagging Pressure Reveals a Giant Case of Fatigue	Scan	10/16 151	(1.0)
Why Fasteners Fall	CD	4/3 162	(2.0)
Selecting Materials to Resist Fatigue	CD	9/4 150	(1.7)
Laser Provides New Data on Impact	Lavoye	3/20 212	(3.0)
Zero Wear	Eayer, Shalkey & Wayson	1/9 142	(10.0)
Designing for Measurable Wear	Bayer & Wayson	8/7 118	(10.0)
Adhesive and Abrasive Wear	Lipson	12/25 74	(4.0)
Pneumatic Line Losses	Wrotten	12/11 182	(4.0)
Damage-Tolerant Design	Osgood	10/30 91	(5.0)
Joint Design	(Chapter) F&J 9/11 12	(12.0)	
Designing Tapered Beams	CD	10/2 144	(3.0)
Bending Fractures, Lesson 4	Lipson	11/27 140	(4.0)
Stress In Noncircular Shafts	Hassoun	6/24 132	(2.0)
Torsional Failures, Lesson 5	Lipson	12/11 186	(4.0)

Lifting Rubber Fingers Curl, Squeeze, and Hold	N/T	10/16 10	(0.8)
"Sea of Tranquillity" for Earthlings With Ulcers	Scan	10/2 117	(1.0)
Off-The-Shelf Underwater Habitat	N/T	11/27 42	(1.0)
Elastic Dummy Will Eject From Jets	N/T	12/11 10	(0.5)
Product Safety	Wise	8/7 19	(15.0)
Pumped-Up Helmets Guard the Gridiron Greats	(Article)	10/16 36	(2.0)
Nobody Knows About Household Accidents When Cars Crash, Bumper Absorbs Collision	N/T	6/26 10	(0.5)
From Door Ramblings, New Safety Standards?	N/T	9/4 10	(1.0)
Commentary Continues	N/T	10/16 14	(0.5)
Books on Tape and TV-Eye Backpack	N/T	12/25 8	(1.0)
Optimizing Working Environments	N/T	5/1 14	(1.2)
Squishy Shoe Lining Distributes Foot Forces	CD	11/27 150	(1.7)
	Scan	12/11 156	(0.5)

## 75. Design Analysis and Synthesis

Organizing Design Problems	Burgess	11/27 120	(8.0)
3-D Graphics	Lavoie	10/30 84	(7.0)
Component Status Chart	Wallenhorst	11/27 111	(3.0)
Product Planning by Computer	Crenren	1/23 161	(2.0)
Systematic Subjectivity: Decision-Making With Utility Theory	Schermerhorn & Taft	2/6 122	(4.0)
Analog Simulator	Cook & Hultin	8/7 128	(4.0)
Radio-Control Models	Spector	11/13 20	(8.0)
Hobbies for Engineers: Think Games	Spector	12/25 28	(3.0)
Piggyback Models Mimic Spacecraft	Wood	1/9 40	(4.0)
Prognosis With Plastic Models	Wright & Bannister	8/21 135	(5.0)
Prognosis With Plastic Models	Wright & Bannister	9/4 136	(5.0)
Prognosis With Plastic Models	Wright & Bannister	10/2 128	(6.0)
Prognosis With Plastic Models	Wright & Bannister	10/16 178	(8.0)
Mountain Models: New Tool for Antenna Designers	N/T	6/26 18	(0.5)
Advanced Simulator Flies Any Combat Mission Realistically	N/T	11/13 64	(0.7)
Elastic Dummy Will Eject From Jets	N/T	12/11 10	(0.5)
Computer Graphics:	Dankowski & Lippert	4/17 226	(7.0)
Part 1—The Engineer and the CRT Terminal	Dankowski & Lippert	5/1 148	(8.0)
Part 2—The Problems You Can Solve	Khol	3/6 127	(3.0)
Computer Matches Designer, Methods Man As Working Team	N/T	1/23 18	(3.0)
From Computer to Microfilm—Nonstop	Kuhn	11/13 174	(6.0)
Use Your QA Capabilities	CD	5/29 136	(2.0)
Estimating Service Life			

## 74. Human Factors Engineering

Machines That Teach—Part 1	Klein	5/29 21	(8.0)
Feeding People On The Go	Spector	10/2 20	(10.0)
Common Sense Needs An Assist	Straus & Carlock	6/24 102	(4.0)
Human Factors Checked Out In DSSV Test	N/T	1/23 10	(0.8)
Human Factors Experts Probe for New Truck-Cab Efficiencies	N/T	3/6 48	(1.0)

An Aerospace Industry Report on TPDT  
Systematic Subjectivity: Minimizing Risk  
Factors in Design .....  
Design for Repairability .....

Black 3/20 177 (3.0)  
Schermerhorn &  
Taft 1/9 120 (4.0)  
Wise 6/26 20 (7.0)

Gyro 'Platform' Added To Hand-Held  
Binoculars .....  
Holograms Shrink Computer Memories .....  
Foul-Weather Viewer Sees Through Fog  
New Treatment for Cancer: Ultrasonics,  
Chilling, and Poison .....  
Ultrasonic Testing of High-Strength  
Alloys .....  
X-15: Black Bullet That Paved a Path  
To the Moon .....

N/T 1/9 10 (0.6)  
N/T 6/26 10 (0.5)  
N/T 1/9 14 (0.5)  
N/T 10/30 40 (0.5)  
CD 3/6 164 (2.5)  
N/T 11/27 30 (5.0)

## 76, 77. Basic Sciences, Experimental, Advanced Design

The Electric Brain .....  
Lunar Experiments Promise Rich Return  
Supercooled Atom-Smashing Electron  
Racecar .....  
Supertrap for Invisible Particles .....  
Measuring Temperature .....

Liquid Crystals—A Film In Your Future?  
Neutron Radiography .....  
Pressure Erases Damage To Irradiated  
Metal .....  
"Sea of Tranquility" for Earthlings With  
Ulcers .....  
Oxygen Sniffer .....  
Grafting Men Together Again  
Epileptics May Get Attack-Warning De-  
vice .....  
Spacecraft Sterilizers Set Bacteria-Toast-  
ing Standards .....  
The Solid-State Cowbell  
Lifting Rubber Fingers Curl, Squeeze,  
and Hold .....  
New Treatment for Cancer: Ultrasonics,  
Chilling, and Poison .....  
Simple Pump Moves Human Blood .....  
Progress In Biomedical Engineering .....  
What Good Is Holography .....  
Optical Computers .....  
Holography: What the Germans Are  
Doing .....  
Optoelectronics .....  
Optoelectronics, Part 2 .....

Khol 5/29 103 (8.0)  
Wise 8/21 30 (4.0)  
  
Spector 3/6 42 (1.0)  
Spector 12/11 40 (4.0)  
  
Lynnworth &  
Benes 11/13 190 (15.0)  
Sprout 2/6 34 (6.0)  
Lavole 2/6 138 (4.0)  
  
N/T 4/17 12 (0.5)  
  
Scan 10/2 117 (1.0)  
Barnes 7/10 47 (2.0)  
Barnes 8/21 20 (7.0)  
  
N/T 6/26 12 (0.6)  
  
N/T 2/20 18 (0.5)  
N/T 7/10 14 (1.3)  
  
N/T 10/16 10 (0.8)  
  
N/T 10/30 40 (0.5)  
N/T 12/25 14 (0.6)  
CD 1/23 172 (3.0)  
Aronson 1/23 26 (17.0)  
Khol 8/21 117 (9.0)  
  
Heumann 9/18 20 (3.0)  
Khol 10/16 156 (12.0)  
Khol 11/13 208 (10.0)

Weather: The Questionable Art of Al-  
teration .....  
Keeping Patient's Cure .....  
Design to Control Corrosion .....  
The Little Yellow Monster-Chasing Sub-  
marine .....  
Trip Guide To Apollo 10 .....  
Twin Mariners Nearing Mars .....  
Elation, Appreciation Stir Scientific Com-  
munity On Eve of Apollo 11 .....  
The Next Big Step: Stations in Space .....  
Research Council Calls for More Spend-  
ing on Satellites .....  
Factories in Orbit Won't Lack Work .....  
All-Purpose Space Station Planned for  
M-70s .....  
Best Window Opening for Outer-Planet  
Flybys .....  
Modular Space Station Could Grow Into  
50-Man Base .....  
Astronauts Will Search for Surveyor  
Human Factors Checked Out In DSSV  
Test .....  
Boom in Bottom Bases .....  
Assault On the Sea .....  
Emergency Air System Ready for Res-  
cue Sub .....  
Ocean-Bottom Drillers Told to Stay At It .....  
Off-The-Shelf Underwater Habitat .....  
Weather .....

Wood 3/20 33 (8.0)  
Barnes 4/3 42 (3.0)  
CD 8/7 136 (2.3)  
  
Spector 7/10 42 (1.0)  
Wise 5/15 36 (4.0)  
Wise 6/24 20 (3.0)  
  
Wise 7/10 36 (4.0)  
Wood 12/25 20 (6.0)  
  
N/T 3/6 18 (0.5)  
N/T 4/17 44 (0.5)  
  
N/T 5/15 15 (0.5)  
  
N/T 6/24 10 (0.5)  
  
N/T 11/13 12 (0.5)  
N/T 11/13 49 (1.0)  
  
N/T 1/23 10 (0.8)  
Barnes 2/6 18 (8.0)  
Wise 4/17 20 (8.0)  
  
N/T 5/15 10 (0.5)  
N/T 11/27 28 (0.6)  
N/T 11/27 42 (1.0)  
Wood 3/6 19 (14.0)

## Engineering Management, Personal

### 81. Engineering Department Operations

Plan Promotes Productivity .....  
Need-To-Know for the Manager-In-Train-  
ing .....  
Lending Engineers .....  
If You Manage Engineers  
How To Move Up Without Dropping Out  
Abilities Are Applied .....  
What Causes Discontent? .....  
The Failure of Functionalism .....  
Spark for Keeping a Project On Schedule  
Bridging the Communications Gap . . . .  
From Your Side .....  
Paper Work for Job Hunting .....  
Help Engineers Grow .....  
  
What's Your JSQ? .....  
Technical Employment Opportunities Show  
Large Gain .....  
Demand Reached New High for Class  
of '69 .....  
Draft Opens Schools To Foreign Engineers  
Sharpest Rise in Engineers' Pay Posted  
In 1968 .....  
Pay Hike OKed for Federal Engineers .....

Kahle 10/2 102 (4.0)  
Karger &  
Murdick 6/24 98 (4.0)  
Lavole 5/29 92 (5.0)  
Rossnagel 8/21 107 (5.0)  
  
Taylor 10/2 98 (4.0)  
(Article) 11/27 108 (3.0)  
Brown 12/11 144 (2.0)  
Brown 5/15 138 (6.0)  
  
D'Aprix 11/13 180 (3.0)  
Carr 8/7 102 (2.0)  
Karger &  
Murdick 9/4 104 (4.0)  
Strauss 5/29 97 (5.0)  
  
N/T 3/6 8 (0.7)  
  
N/T 8/7 8 (0.7)  
N/T 5/15 8 (0.8)  
  
N/T 7/10 8 (1.0)  
N/T 10/2 8 (0.6)

Resistance Wire Cycles Test Load Ap-  
plication .....  
Test Chamber Simulates the Rigors of  
Re-entry .....  
Nine-Lane Track Tests New Tires .....  
Accelerating Lubricants Tests .....

Scan 1/9 133 (0.7)  
Scan 3/20 14 (1.3)  
DI 11/27 48 (1.0)  
CD 10/16 188 (2.2)

### 85. Technical Information

Government Information Sources .....  
Ultrasonic Testing of High-Strength  
Alloys .....  
Engineering Standards for Small Com-  
panies .....  
Read It Like It Is .....  
Building 'Show Biz' Into Technical Talks  
Speech-Making for the Unaccustomed  
Engineer .....

Clarke 10/30 96 (8.0)  
CD 3/6 164 (2.5)  
Landau 10/16 140 (6.0)  
Ebel 3/20 175 (3.0)  
D'Aprix 4/3 127 (4.0)  
Prahatis 12/11 146 (3.0)

### 82-84. New Products, Drafting, Testing

Riot Control .....  
Product Planning by Computer .....  
Ingredients for Successful Proposals .....  
Before It's Too Late, Denovate .....  
Guidance System for Innovation .....  
R&D: Term for Accountants Only .....  
Project Task Teams .....  
Eliminating Vanishing-Point Spread  
Electric Photography Developed Without  
Silver .....  
Supercameras Create Precise Circuit  
Boards .....  
New Techniques in Joining .....  
From Computer To Microfilm—Nonstop  
Just the Fax .....  
A New Engineering Facility .....  
Nondestructive Testing With Plastic Models .....  
Tire Makers Devise Nondestructive Test

Aronson 1/9 22 (9.0)  
Correns 1/23 161 (2.0)  
DeGeorge 4/3 122 (5.0)  
Spector 4/3 20 (7.0)  
Spector 9/18 26 (5.0)  
N/T 6/24 8 (0.7)  
Stratton 6/26 102 (5.0)  
Duncan 8/21 139 (1.0)  
  
N/T 1/9 12 (0.5)  
  
N/T 10/16 12 (0.5)  
CD 8/21 144 (1.5)  
N/T 1/23 18 (3.0)  
Klein 2/20 29 (6.0)  
Goldberg 3/6 125 (2.0)  
Lavole 9/4 121 (15.0)  
  
Wright &  
Bannister 8/21 135 (5.0)  
N/T 8/21 10 (0.5)

### 87, 88. Personal, Professional, Outside Services

How the New Grads Measure Up .....  
Help Engineers Grow .....  
Noble Motives and Rich Rewards .....  
Technology's Privileged Offspring .....  
The New Social Involvement .....  
The Engineer As a Professional .....  
The Engineer's Image .....  
Living With Runaway Technology .....  
Revolution in Engineering Education .....  
They'd Rather Stay Than Switch .....  
Shape Up and Act Professional, Design-  
ers Are Told .....  
Forcing Ideas With Syncetics .....  
Ten Draftsmen Honored With Grand De-  
sign Awards .....  
Are Creative Engineers "More Equal?"  
Than Others .....  
Making Meetings Count .....  
Games Engineers Play .....  
Promote Your Idea .....  
Radio-Control Models .....  
International Mechanisms Group Estab-  
lished .....  
New Engineering Society Slow Getting  
Started .....  
Wescon Industrial Design Awards .....

Chipman 9/18 227 (3.4)  
Karger &  
Murdick 9/4 104 (4.0)  
Khol 9/18 178 (12.0)  
Klein 9/18 198 (6.0)  
Marlowe 9/18 218 (2.5)  
Robbins 9/18 221 (3.8)  
Ruder 9/18 225 (2.6)  
Spector 9/18 190 (8.0)  
Tribus 9/18 215 (3.6)  
(Article) 12/25 50 (4.0)  
  
N/T 8/7 42 (0.6)  
Raudsepp 10/16 134 (6.0)  
  
N/T 1/9 21 (1.0)  
  
N/T 7/10 106 (4.0)  
Zawacki 1/23 130 (3.0)  
Raudsepp 2/20 130 (6.0)  
Herzog 3/6 122 (3.0)  
Spector 11/13 20 (8.0)  
  
N/T 10/30 42 (0.7)  
  
N/T 11/13 66 (0.7)  
N/T 8/21 36 (2.0)

# Specific Machines and Equipment

## 911. Ordnance

An Album of Design . . . . .	(Article)	9/18	214	(11.0)
riot Control . . . . .	Aronson	1/9	22	(9.0)
Where Roads Don't Count . . . . .	Aronson	5/1	36	(7.0)
European Fighter Aircraft . . . . .	Aronson	10/18	44	(6.0)
New Ideas for Artillery . . . . .	Aronson	12/11	26	(2.0)
Design for Battlefield Survival . . . . .	Orgorkiewicz	11/13	36	(8.0)
New Armor Materials . . . . .	Orgorkiewicz	11/27	36	(4.0)

## 912. Machinery

Mechanizing the Malls . . . . .	Klein	3/20	20	(7.0)
Universal Power Units . . . . .	Zimmerman	11/13	52	(3.0)
Safe Power Lawn Mower Throws Debris Forward . . . . .	N/T	10/2	42	(1.0)
Truck's Load Slides on "Window Shades" . . . . .	N/T	11/27	14	(1.3)
Air Knives Strip Sterilizer From Milk Wrapper . . . . .	Scan	10/2	118	(0.5)

## 913. Electrical Machinery

Underwater Watchdogs . . . . .	Boyd	5/29	31	(4.0)
Multiplexing Takes Off . . . . .	Klein	6/26	34	(5.0)
The ABCs of CATV . . . . .	Klein	11/27	20	(5.0)
On the Beat With the Electronic Cop . . . . .	Spector	4/3	39	(2.0)
The Self-Cleaning Oven Derby . . . . .	Spector	4/17	47	(4.0)
Feeding People On the Go . . . . .	Spector	10/2	20	(10.0)
Research Hope to Shock-Proof Radar . . . . .	N/T	3/6	14	(0.5)
Prototype Ready for Hang-On-Wall TV . . . . .	N/T	6/24	10	(0.5)
Telephone Pictures Show What Computer Remembers . . . . .	N/T	6/24	14	(0.5)
Laser Finds Job in Home-Entertainment System . . . . .	N/T	10/30	12	(0.7)
Coming: The Trash Masher . . . . .	N/T	11/27	45	(0.7)
Design Program Previews Home Appliances of the Future . . . . .	N/T	12/11	32	(2.0)
Switch to D-C Leaves Turntable Wowless	Scan	10/2	119	(0.5)

## 914. Transportation

Foreign Car Sampler . . . . .	Aronson	2/20	47	(4.0)
River-Boat Design . . . . .	Aronson	7/10	20	(9.0)

The Zeppelins Are Coming (Again?) . . . . . Heumann  
The Urban Mobility Hang-Up . . . . . Wise  
Stripes, Scoops, and Spoilers—Signs of the Swinging '70s . . . . .

Andy at Indy . . . . . Wise  
Piggyback Models Mimic Spacecraft . . . . . Wood & Wise  
The Automated Sky . . . . . Wood  
Universal Power Units . . . . . Zimmerman

Escape Machines for All Seasons: ATVs . . . . . Zimmerman  
People-Carrying Cylinders Pop Out of Pneumatic Tubes . . . . . Zimmerman

Tampa Solver Terminal Sprawl . . . . . N/T  
From Junk Cars, India's Tractors? . . . . . N/T  
Go-Ahead Given on Big Surface-Effect Ship . . . . . N/T

Granatelli Goes Conventional, Almost . . . . . N/T  
Frontier Runways Pose No Problems . . . . . N/T  
Ford's Maverick: Bred and Built by Computer . . . . . N/T

World War II Airplanes Make a Mini-Comeback . . . . . N/T  
Not a Warmed-Over F-111 . . . . . N/T

Return of the Hornet . . . . . N/T  
Build It, Then Fly It Away . . . . . N/T  
Air Bag Passes Taxing Tests . . . . . N/T

Balloon Floats Downed Pilot Out of Enemy's Reach . . . . . N/T  
Parentheses Propel Platform . . . . . N/T  
Braking Study Seeks Best Runway . . . . . N/T

Steamer Assaults Speed Record . . . . . N/T  
Three Aircraft Endurance Records Fall . . . . . N/T  
Special Hoist Serves "Harrier" VTOL . . . . . DI

New Fiat Has Front-Wheel Drive . . . . . DI  
Frankfurt Auto Show Previewed . . . . . DI

VW '70 . . . . . DI  
Holden Hurricane . . . . . DI  
Italian Luxury Car . . . . . DI

Opel Idea Car . . . . . DI  
Four People-Movers: 30 by Capsule . . . . . DI  
The Walking Truck . . . . . (Article)

9/18 25 (0.5)  
10/30 34 (1.0)  
10/30 44 (0.7)  
11/13 14 (1.3)  
12/25 10 (0.5)  
5/29 48 (0.5)  
5/29 48 (0.5)  
8/21 41 (0.5)  
9/18 38 (2.0)  
10/2 34 (1.0)  
10/2 39 (0.5)  
10/30 47 (0.5)  
10/30 50 (0.7)  
4/17 32 (3.0)

## 915. Instruments

Photo Enlargements in a Minute . . . . .	Spector	9/18	14	(1.3)
Scanning Electron Microscope . . . . .	(Article)	6/24	106	(7.0)
Thermistorized Nosepiece Makes Breathing Easier . . . . .	Scan	11/13	188	(0.5)

Using the classification system provides nine major (one-digit) classifications, each of which has up to nine (two-digit) sub-classifications. These, in turn, are divided into ten (three-digit) indexing classifications.

Indexing classifications ending in 0 (General) are used to index material concerning several or all indexing classifications ending in 1 through 8. Classifications ending in 9 (Other) are used for material falling within the sub-classification but not within any of the items 1 through 8.

# MACHINE DESIGN Subject Classification System

## 1-ELECTRICAL & ELECTRONIC

- 11 Motors**
  - 110 General
  - 111 Fractional (less than 1 hp)
  - 112 Ac integral horsepower
  - 113 Dc integral horsepower
  - 114 Universal (dc and ac)
  - 115 Multispeed
  - 116 Gearmotors
  - 117 Torque
  - 118 Definite and special purpose
  - 119 Other
  
- 12 Power Supplies**
  - 120 General
  - 121 Batteries (dry and wet)
  - 122 Dc generators, motor-generators
  - 123 Ac generators (alternators), motor-generators
  - 124 Converters, inverters
  - 125 Transformers
  - 126 Fuel cells, solar cells, photo cells
  - 127 Thermoelectric supplies
  - 128
  - 129 Other
  
- 13 Switches & Relays**
  - 130 General
  - 131 Mechanical (pushbutton, lever, rotary, mercury)
  - 132 Thermally operated (thermostats)
  - 133 Pressure operated
  - 134 Limit
  - 135 Proximity, photoelectric
  - 136 Stepping
  - 137 Relays, circuit breakers
  - 138 Motor starters (motor controls)
  - 139 Other (reed)
  
- 14 Instruments & Controls**
  - 140 General
  - 141 Sensing devices (transducers, thermo-couples)
  - 142 Solenoids, electric actuators
  - 143 Timers, timing motors, delays
  - 144 Synchros
  - 145 Instrument motors
  - 146 Data recorders, readouts, indicators
  - 147 Meters, gages
  - 148 Servo motors, stepping motors
  - 149 Other

## 2-FLUID POWER

- 21 Fluids**
  - 210 General
  - 211 Hydraulic fluids
  - 212 Coolants
  - 213
  - 214
  - 215
  - 216
  - 217
  - 218
  - 219 Other
  
- 22 Fluid Conditioners**
  - 220 General
  - 221 Fluid storage (pressure vessels)
  - 222 Filters, strainers
  - 223 Renovators
  - 224 Heat exchangers
  - 225 Coolers
  - 226 Heaters
  - 227 Driers
  - 228
  - 229 Others
  
- 23 Fluid Conductors**
  - 230 General
  - 231 Tubing (pressure)
  - 232 Hose
  - 233 Pipe
  - 234 Fittings
  - 235 Joints, couplings
  - 236
  - 237
  - 238
  - 239 Other
  
- 24 Linear Devices**
  - 240 General
  - 241 Cylinders
  - 242 Accumulators
  - 243 Intensifiers
  - 244 Actuators (bellows, diaphragms)
  - 245 Pumps (linear)
  - 246
  - 247
  - 248
  - 249 Other
  
- 25 Rotary Devices**
  - 250 General
  - 251 Pumps (rotary)
  - 252 Fluid Motors
  - 253 Air motors
  - 254 Compressors

- 15 Circuit Components**
  - 150 General
  - 151 Resistors (rheostats, potentiometers)
  - 152 Capacitors
  - 153 Inductors
  - 154 Solid-State devices (diodes, transistors, SCR's, rectifiers, semiconductors, integrated circuits)
  - 155 Tubes
  - 156 Saturable reactors (magnetic amplifiers)
  - 157 Fuses
  - 158 Lasers, masers
  - 159 Other
  
- 16 Connectors & Wiring**
  - 160 General
  - 161 Rings, brushes, commutators
  - 162 Terminals, binding posts
  - 163 Contacts (buttons)
  - 164 Plugs, receptacles, connectors
  - 165 Wiring (cable, cord, coil, harness)
  - 166 Printed circuits, stitched circuits
  - 167
  - 168
  - 169 Other
  
- 17 Miscellaneous Components**
  - 170 General
  - 171 Electromagnets, magnets
  - 172 Chassis, control panels
  - 173 Insulation, encapsulation, shielding
  - 174 Cooling elements
  - 175 Lamps, lighting elements (fiber optics)
  - 176 Heaters, heating elements
  - 177 Electric clutches & brakes
  - 178
  - 179 Other
  
- 19 Systems & Assemblies**
  - 190 General
  - 191 Amplifiers, preamps
  - 192 Control systems (regulators, numerical control)
  - 193 Electronic computers
  - 194 Other electronic
  - 195 Adjustable-speed drives
  - 196 Servomechanisms
  - 197 Other electromechanical
  - 198 Packaging
  - 199 Other

## 3-MECHANICAL

- 31 Power Sources**
  - 310 General
  - 311 Jet engines
  - 312 Internal-combustion engines
  - 313 Turbines
  - 314 Atomic, nuclear power
  - 315 Exotic fuel engines (rockets)
  - 316 Fuels, propellants
  - 317
  - 318
  - 319 Other
  
- 32 Constant-Speed Drives & Transmissions**
  - 320 General (speed reducers)
  - 321 Chain
  - 322 Belt
  - 323 Friction (ball, disc, wheel, cone)
  - 324 Gear
  - 325
  - 326
  - 327
  - 328
  - 329 Other
  
- 33 Adjustable-Speed Drives & Transmissions**
  - 330 General (speed reducers)
  - 331 Chain
  - 332 Belt
  - 333 Friction (ball, disc, wheel, cone)
  - 334 Gear
  - 335
  - 336
  - 338
  - 339 Other
  
- 34 Drive Components**
  - 340 General
  - 341 Transmission chain, cable
  - 342 Belts, belting
  - 343 Gears, gearing
  - 344 Sprockets
  - 345 Pulleys, sheaves
  - 346 Conveyor chain, conveyor cable
  - 347 Conveyor screws
  - 348
  
- 36 Mechanisms**
  - 360 General
  - 361 Cams
  - 362 Linkages
  - 363 Intermittent-motion (periodic-motion, indexing)
  - 364 Three dimensional
  - 365 Motion converters (leadscrews)
  - 366 Spring motors
  - 367
  - 368
  - 369 Other
  
- 37 Controls**
  - 370 General
  - 371 Push-pull
  - 372 Transducers (to mechanical)
  - 373 Gyros, gyroscopes
  - 374 Counters
  - 375
  - 376
  - 377
  - 378
  - 379 Other
  
- 39 Systems**
  - 390 General

## 4-ASSEMBLY COMPONENTS

- 41 Fasteners**
  - 410 General
  - 411 Inserts
  - 412 Nuts
  - 413 Pins
  - 414 Quick operating (panel-type, latches)
  - 415 Retaining rings, keys, collars
  - 416 Rivets
  - 417 Screws, bolts, studs
  - 418 Washers, grommets, eyelets
  - 419 Other (spring clips, clamps)
  
- 42 Springs & Isolation Devices**
  - 420 General
  - 421 Fluid & air springs
  - 422 Helical-wire springs
  - 423 Leaf springs
  - 424 Vibration isolators, mounts
  - 425 Hydraulic-damping devices (shock absorbers, snubbers)
  
- 43 Miscellaneous**
  - 430 General
  - 431 Locks
  - 432 Nameplates, labels
  - 433 Dials, knobs, handles
  - 434 Shims
  - 435 Enclosures
  - 436 Wheels, tires, rollers, casters
  - 437 Slides
  - 438 Hinges, brackets
  - 439 Other
  
- 49 General**
  - 490 General

## 5-MATERIALS

- 51 Ferrous Metals**
  - 510 General
  - 511 Cast iron, malleable iron, cast carbon, alloy steel
  - 512 Wrought carbon, alloy steels
  - 513 Free-machining steels
  - 514 Stainless steels, high alloys, high-temperature steels
  - 515 Specialty steels (tool, die, electrical)
  - 516
  - 517
  - 518
  - 519 Other
  
- 52 Nonferrous Metals**
  - 520 General
  - 521 Aluminum
  - 522 Copper, Brass, Bronze
  - 523 Magnesium
  - 524 Nickel
  - 525 Titanium
  - 526 Zinc
  - 527 Refractory metals (tungsten, tantalum, molybdenum, columbium)
  - 528 Precious metals
  - 529 Other
  
- 53 Plastics**
  - 530 General
  - 531 Thermoplastic plastics (nylon, Teflon)
  - 532 Thermosetting plastics (epoxy, phenolic, filled silicones, rigid urethanes)
  - 533 Brazing, soldering alloys
  - 534 Hard rubber
  - 545
  - 546
  - 547
  - 548
  - 549 Other
  
- 55 Joining Materials**
  - 550 General
  - 551 Adhesives, sealants
  - 552 Welding rods
  - 553 Brazing, soldering alloys
  - 554
  - 555
  - 556
  - 557
  - 558
  - 559 Other

## 5—MATERIALS (continued)

56 Other Nonmetals	576 Lubricating materials
560 General	577
561 Carbon, graphite	578
562 Glass, ceramics	579 Other
563 Refractory materials, mica	
564 Carbides, cermets	
565 Mineral & synthetic fibers, felt	
566 Insulating materials (thermal)	
567 Wood, cork, composition board, paper	
568 Chemicals	
569 Other	
57 Finishes, Coatings & Lubricants	
570 General	
571 Metallic coatings	
572 Chemical coatings, electrochemical coatings	
573 Organic finishes (lacquers, synthetic enamel), paints, varnishes	
574 Porcelain enamels, vitreous coatings	
575 Plastic coatings	

## 6—MANUFACTURING PROCESSES

61 Metal Casting	651 Planing, broaching
610 General	652 Lathe, screw machining
611 Sand	653 Milling, hobbing, gear shaping
612 Shell mold	654 Drilling, boring
613 Permanent mold	655 Grinding, abrasive machining
614 Centrifugal	656 Honing, lapping, polishing
615 Investment	657 High-energy machining (spark, laser)
616 Die	658
617	659 Other
618	
619 Other	
62 Metal Shaping	
620 General	660 General
621 Forging	661 Heat treating
622 Extrusion, impact extrusion	662 Surface treating (carburizing, nitriding)
623 Heading, upsetting	663 Shot peening, surface working
624 Thread, form rolling	664 Chemical milling, etching
625 Powder metallurgy	665
626	666
627	667
628	668
629 Other	669 Other
63 Metal Forming	
630 General	670 General
631 Sheet, plate forming	671 Chemical, solvent cleaning
632 Stamping, drawing	672 Mechanical finishing
633 High-velocity forming (explosive forming)	673 Conversion coating (anodizing), electro-polishing
634 Spinning	674 Electropolating, vacuum metallizing
635 Roll forming	675 Metal spraying (flame spraying), hard facing
636 Tube forming	676 Painting
637 Wire forming	677
638	678
639 Other	679 Other
64 Metal Joining	
640 General	680 General
641 Arc welding	681 Molding
642 Gas welding	682 Extrusion
643 Resistance welding	683 Sheet forming
644 High-energy welding (plasma, electron beam, explosive bonding)	684 Laminating
645 Flame cutting	685 Casting
646 Brazing	686 Stamping, machining, fabricating, forming
647 Soldering	687 Calendering, coating
648 Adhesive joining, bonding	688 Encapsulation
649 Other	689 Other (filament winding)
65 Metal Removal	
650 General	690 General

## 7—DESIGN THEORY & TECHNIQUES

71 Mechanics	73 Strength of Parts
710 General	730 General
711 Statics (at rest)	731 Tension, compression
712 Dynamics (force to create motion)	732 Bending
713 Kinematics (motion in abstract)	733 Shear, torsion
714 Vibration	734 Surface contact stress
715 Shock	735 Plates
716 Noise, sound, music	736 Cylinders, columns
717	737 Rotating discs
718	738
719 Other	739 Other
72 Strength of Materials	
720 General	74 Human-Factors Engineering
721 Elastic theory	740 General
722 Plastic theory	741 Styling
723 Fatigue, endurance	742 Color
724 Creep	743 Safety
725 Impact stress	744 Illumination
726 Thermal stress	745 Human limitations
727 Friction	746
728	747
729 Other	748
	749 Other

## 7—DESIGN THEORY & TECHNIQUES (continued)

75 Design Analysis & Synthesis	771 Prototypes, breadboards
750 General	772 Testing (stress analysis)
751 Mathematical methods (statistics)	773
752 Graphical techniques	774
753 Analogs, models	775
754 Computer techniques	776
755 Reliability, quality control	777
756 Dimensioning (tolerances)	778
757	779 Other
758	
759 Other	
76 Basic Sciences & Fields	
760 General	780 General
761 Physics	781 Corrosion, rust
762 Chemistry	782 Mold, fungus
763 Thermal (cryogenics, heat transfer)	783 Outer space
764 Radiation	784 Under sea
765 Biosciences	785
766 Optics (photography)	786
767 Ultrasonics	787
768	788
769 Other	789 Other
79 General	
790 General	
77 Experimental Design	
770 General	

## 8—ENGINEERING MANAGEMENT & OPERATION

81 Engineering Department Operations	d55 Part numbering
810 General	856 Engineering records
811 Structure, organization	857
812 Costs	858
813 Programming, planning	959 Other
814 Personnel policies	
815 Recruiting, evaluation, training	
816 Managerial talent	
817 Compensation	
818	
819 Other	
82 New Product Development	
820 General	
83 Drafting & Reproduction	
830 General	
831 Management, control systems	
832 Drafting practices, techniques	
833 Technical illustration	
834 Drafting equipment	
835 Reproduction equipment, systems	
836 Furniture	
837	
838	
839 Other	
84 Laboratory & Testing	
840 General	
85 Technical Information	
850 General	
851 Engineering libraries, files	
852 Information classification, retrieval	
853 Specifications, standards	
854 Report writing, articles, papers, oral	
86 Patents & Patent Law	
860 General	
87 Personal & Professional	
870 General	
871 Creativity, inventiveness	
872 Meetings, shows	
873 Other personal	
874 Societies	
875 Professional licensing	
876 Unions	
877	
878	
879 Other professional	
88 Outside Services	
880 General	
881 Engineering design services	
882 Industrial design services	
883	
884	
885	
886	
887	
888	
889 Other	
89 General	
890 General	

## 9—MISCELLANEOUS

91 Complete Machines	photographic, watches, SIC 38)
910 General	916 Fabricated metal products (hand tools, etc., SIC 34)
911 Ordnance (tanks, missiles, rockets, ammunition, SIC 19)	917
912 Machinery (agricultural, construction, machine tools, office machinery, materials handling, SIC 35)	918
913 Electrical machinery (communications, radio radar, TV, appliances, X-ray, SIC 36)	919 Other
914 Transportation (automotive, aircraft, ships, railroad, SIC 37)	
915 Instruments (medical, dental,	
99 Unclassified	
990 General	(includes pages such as Editorials, "Back Talk," Covers, Contents Pages, etc.)

